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H4L LDLX

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GB 2313259 A WO 96/28809 A1 WO 96/24200 A1
US 5537503 A

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(54) Abstract Title
Method and apparatus for discontinuous transmission

(57) In discontinuous transmission (DTX), speech data is not transmitted during speech pauses but instead data relating to the background is transmitted in a fraction of the time slots on the air interface. In the invention, a channel coder 113 enters discontinuous transmission when it receives a silence descriptor frame (known as SID in GSM) followed by a false frame and exits discontinuous transmission when it receives a speech frame. A silence descriptor frame is a frame containing data relating to background noise rather than speech and false frames include all frames which are not received as speech or silence descriptor frames. These false frames generally correspond to frames received in error but also includes frames which are generated by the receiver during the pauses of a discontinuous transmission. According to the invention, channel coding providing discontinuous transmission is performed based only on false frames, silence descriptor frames and speech frames with no requirements of additional information from a speech coder (111, fig. 1). The invention is applicable but not limited to a GSM system using discontinuous transmission while in tandem free operation (fig.2). Also discussed is the transmission of fill frames when a false frame is received in continuous transmission.

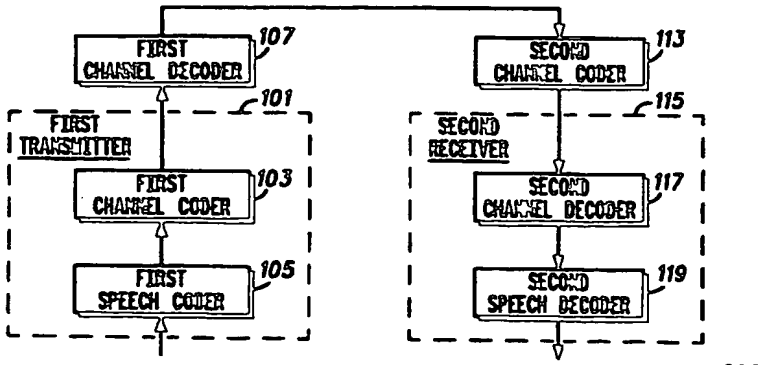

FIG. 2

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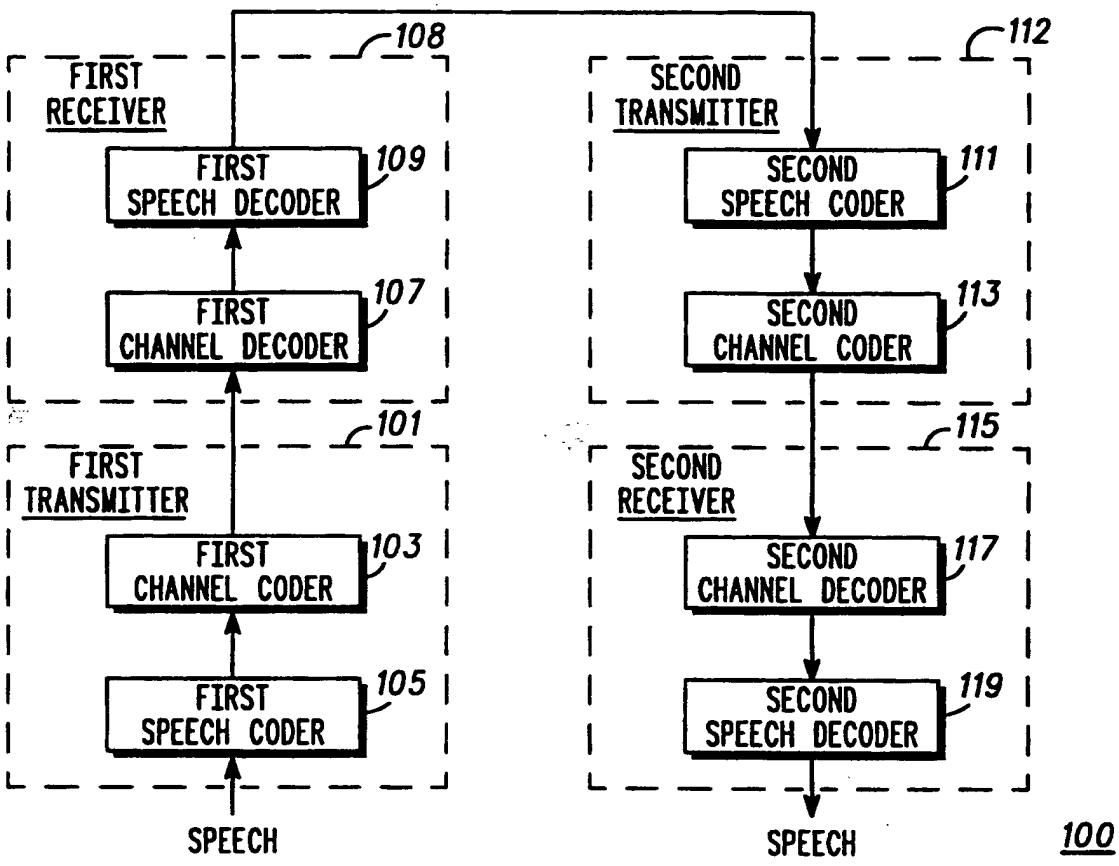

108
FIRST
RECEIVER
FIRST
SPEECH DECODER
109
FIRST
CHANNEL DECODER
107
101
FIRST
TRANSMITTER
FIRST
CHANNEL CODER
103
FIRST
SPEECH CODER
105
SPEECH
112
SECOND
TRANSMITTER
SECOND
SPEECH CODER
111
SECOND
CHANNEL CODER
113
115
SECOND
RECEIVER
SECOND
CHANNEL DECODER
117
SECOND
SPEECH DECODER
119
SPEECH
100

FIG. 1

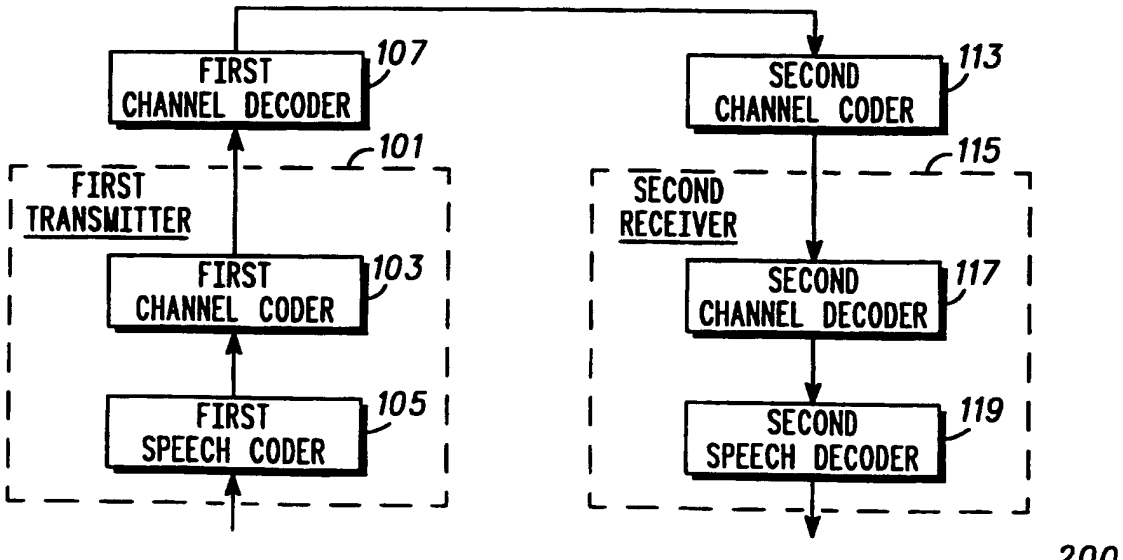
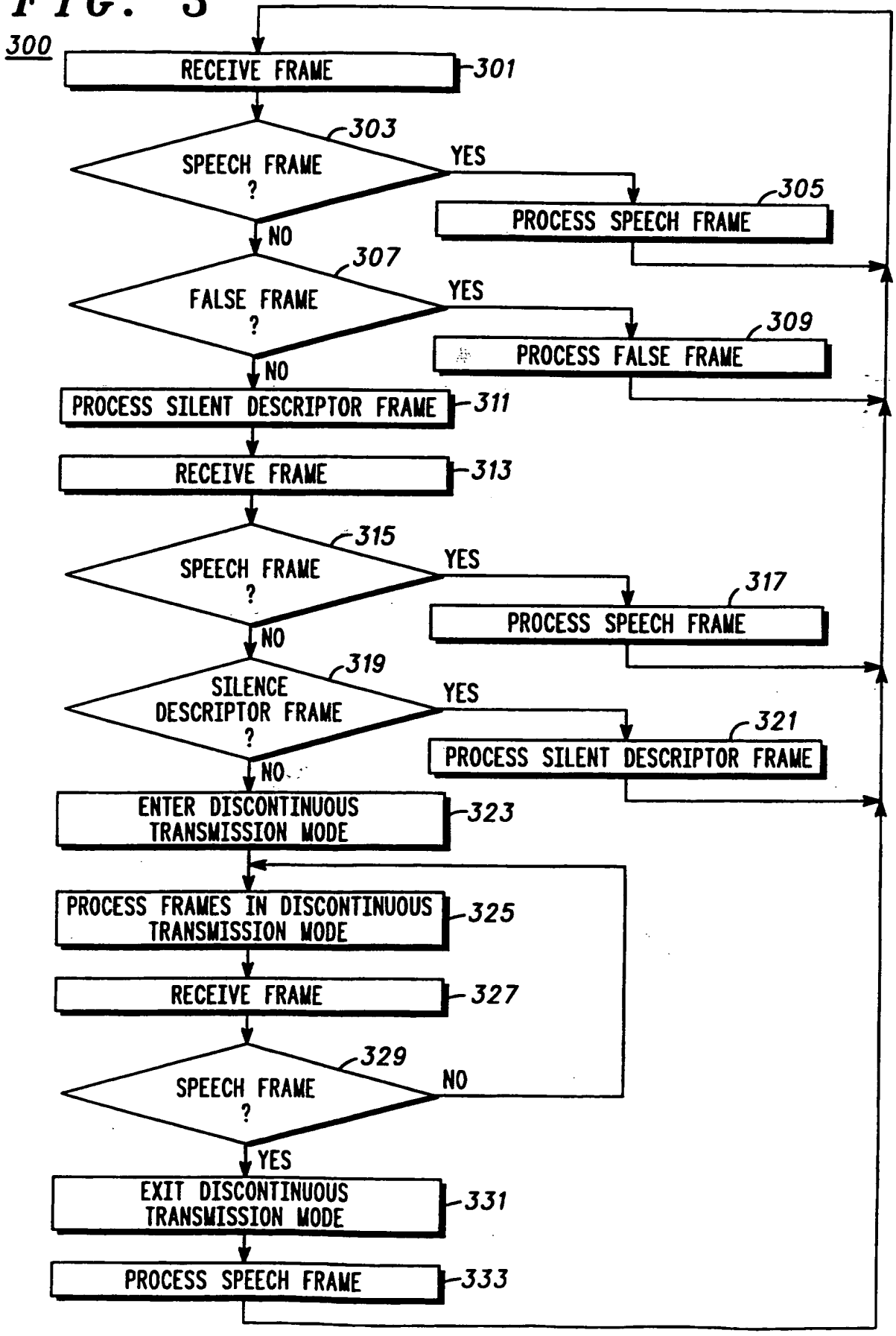

FIRST
CHANNEL DECODER
107
101
FIRST
TRANSMITTER
FIRST
CHANNEL CODER
103
FIRST
SPEECH CODER
105
SECOND
CHANNEL CODER
113
115
SECOND
RECEIVER
SECOND
CHANNEL DECODER
117
SECOND
SPEECH DECODER
119
200

FIG. 2

FIG. 3


300
RECEIVE FRAME
301
SPEECH FRAME ?
303
YES
PROCESS SPEECH FRAME
305
NO
FALSE FRAME ?
307
YES
PROCESS FALSE FRAME
309
NO
PROCESS SILENT DESCRIPTOR FRAME
311
RECEIVE FRAME
313
SPEECH FRAME ?
315
YES
PROCESS SPEECH FRAME
317
NO
SILENCE DESCRIPTOR FRAME ?
319
YES
PROCESS SILENT DESCRIPTOR FRAME
321
NO
ENTER DISCONTINUOUS TRANSMISSION MODE
323
PROCESS FRAMES IN DISCONTINUOUS TRANSMISSION MODE
325
RECEIVE FRAME
327
SPEECH FRAME ?
329
NO
YES
EXIT DISCONTINUOUS TRANSMISSION MODE
331
PROCESS SPEECH FRAME
333

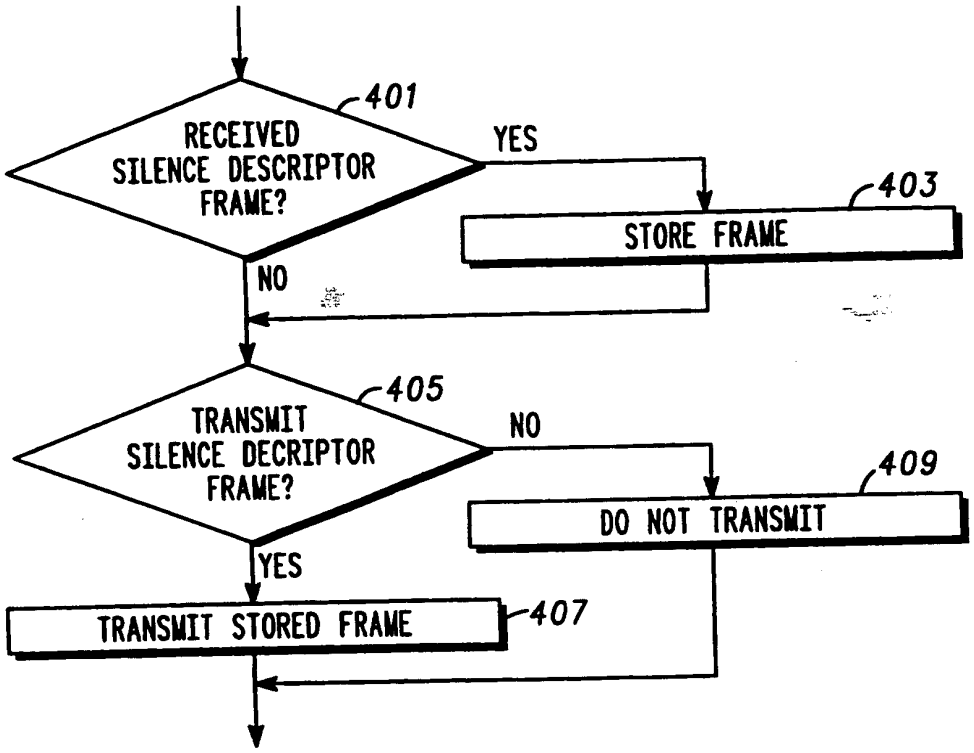

401
RECEIVED SILENCE DESCRIPTOR FRAME?
YES
403
STORE FRAME
NO
405
TRANSMIT SILENCE DECRIPTOR FRAME?
NO
409
DO NOT TRANSMIT
YES
TRANSMIT STORED FRAME
407
325

FIG. 4

2332598

METHOD AND APPARATUS FOR DISCONTINUOUS TRANSMISSION

Field of the Invention

This invention relates to a method and apparatus for discontinuous transmission in a communication system

Background to the Invention

In many communication systems using circuit switched technology a static communication link is set up between a receiver and a transmitter independently of the instantaneous use of this link. An example is a standard telephone connection where the connection is static throughout the call independently of whether the users are talking or not.

Another example is in the Global System for Mobile communications (GSM) where a transmitter in standard mode will transmit a constant data rate independent of the pauses in speech. This results in unnecessary transmissions which increase the level of interference caused by the given call. In order to reduce the interference, the GSM specifications include an option for discontinuous transmission (DTX) where speech data is not transmitted during speech pauses. Instead data relating to the background is transmitted in a fraction of the time slots on the air interface.

The speech coders used in GSM generate data in speech frames, and in order to apply discontinuous transmission, speech coders have been developed which for each frame determines whether the frame contains speech or not. This information is provided to the transmitter together with the frame and the information is used by a channel coder to determine what is to be transmitted. The act of converting the frames into the appropriate format for transmission is known as channel coding and the functional block of the transmitter is known as a channel coder. The frames containing data relating to background noise rather than speech data are denoted silence descriptor frames or specifically SID frames in GSM. The GSM speech coder thus generates either a speech frame or a silence descriptor frame in each frame interval. If operating

discontinuous transmission only a fraction of the silence descriptor frames will be transmitted over the air interface by the channel coder.

In a communication system such as GSM, the base station contains a speech decoder translating the frames received from the mobile into uncompressed speech data which is then routed to another base station when the call is between two mobiles. When receiving from a mobile there is, in addition to receiving speech frames and silence descriptor frames, a possibility of receiving false frames. False frames include all frames which are not received as speech frames or silence descriptor frames, and generally corresponds to frames received in error. It also includes frames which are generated by the receiver during the pauses of a discontinuous transmission. The speech coder will compensate for these false frames when generating the speech signal from the received frames.

The speech quality of a mobile to mobile call can be improved if the speech encoding and decoding performed in the two connected base stations are bypassed. This is known as tandem free operation and is currently being included in the specifications of the GSM system. However, as the known method for achieving discontinuous transmissions utilises information generated by the speech coder this method is no longer feasible for a call using tandem free operation.

Thus, it would be advantageous to provide a method for discontinuous transmission in tandem free operation.

Summary of the Invention

According to the present invention, a method is provided for discontinuous transmission in a communication system comprising the steps of : entering a discontinuous transmission mode when a first silence descriptor frame is followed by a first false frame; and leaving the discontinuous transmission mode when a first speech frame is received.

The method may further include the steps of storing a second silence descriptor frame; and when in discontinuous transmission mode, transmitting said second silence descriptor frame until a third silence descriptor frame is received, when a transmission of a silence descriptor frame is required by a protocol.

According to a second aspect of the invention, a method is provided for channel coding in a communication system comprising the step of transmitting a fill frame when not in a discontinuous transmission mode and a false frame is received.

According to a different aspect of the invention there is provided a transmitter in a communication system providing discontinuous transmission comprising: means for entering a discontinuous transmission mode when a first silence descriptor frame is followed by a first false frame; and means for leaving the discontinuous transmission mode when a first speech frame is received. The transmitter may also include means for storing a second silence descriptor frame; and means for when in discontinuous transmission mode, transmitting said second silence descriptor frame until a third silence descriptor frame is received, when a transmission of a silence descriptor frame is required by a protocol.

The invention thus provides means for achieving discontinuous transmission from a transmitter including a channel coder with inputs consisting of speech frames, silence descriptor frames and false frames and without requiring information to be provided from a speech coder.

Brief Description of the Drawings

An embodiment of the present invention is described below, by way of example only, with reference to the accompanying drawings.

FIG. 1 is an illustration of a communication system for speech according to the prior art, in this example the GSM system.

FIG. 2 is an illustration of a communication system employing tandem free operation.

FIG. 3 is an illustration of a flowchart for a method of providing discontinuous transmission.

FIG. 4 is an illustration of a flowchart for a method for processing frames when in discontinuous transmission mode.

Detailed Description of a Preferred Embodiment

An example of a communication system 100 which can utilise discontinuous transmission is illustrated in FIG. 1. The example given here corresponds to a mobile to mobile call in the GSM communications system.

A first transmitter 101 transmitting a speech signal contains a first speech coder 105 and a first channel coder 103. The speech coder 105 converts the speech signal into a suitable data format. This conversion will typically include some form of speech compression. The channel coder 103 converts the data from the speech coder 105 into a form suitable for transmission to a first receiver 108. This receiver contains a first channel decoder 107 converting the receiver data into a format suitable for a first speech decoder 109 which converts the data into a speech signal. The channel coder and decoder typically includes functions for forward error correcting coding and decoding as well as interleaving and deinterleaving.

The received speech signal is routed to a second transmitter 112 containing a second speech coder 111 and second channel coder 113. The transmitted signal is received by a second receiver 115 containing a second channel decoder 117 and a second speech decoder 119.

In the example of a GSM communication system the first transmitter 101 will correspond to a first mobile uplinking to a first base station. The first

receiver 108 will correspond to the receiver of this base station and the received speech signal will in this case be routed through the GSM network to a second base station. In the example given, the second transmitter 112 corresponds to the transmitter of this second base station downlinking to a second mobile represented by the second receiver 115.

The sequence of the first speech decoder 109 followed directly by the second speech coder 111 results in degraded quality as the speech decoding and coding process is lossy. Improved quality is therefore possible if these are bypassed as shown in FIG. 2. This option of bypassing the speech decoding and coding performed in the two base stations is being included in the specifications for the GSM system and is known as tandem free operation.

Discontinuous transmission of a speech signal can significantly reduce the resource use and interference in a communication system. GSM includes an option for discontinuous transmission wherein data relating to background noise is transmitted at a much lower data rate during speech pauses. The discontinuous transmission is controlled by the channel coders based on the input from the speech coders. Referring to FIG. 1, discontinuous transmission between the second transmitter 112 and the second receiver 115 will be controlled by the second channel coder 113 based on input from the second speech coder 111. The current invention considers the case where tandem free operation is achieved by feeding the frames generated by the first channel decoder 107 directly to the second channel coder 113.

The following description considers a separate speech decoder and encoder situated in the first and second base station. However, the invention is by no way limited to this situation and it will be apparent to the skilled person that the functions performed by the channel encoder and decoder can be performed elsewhere or distributed in the system.

The second channel coder 113 is therefore not provided with information from the second speech coder. In addition, the channel coder will generate frames which would not be generated by a speech coder. These frames called false frames can for example include frames which are received

with too many errors to be correctly decoded, or frames which are generated during pauses in a discontinuous transmission.

In the example of a GSM communication system the speech coder receives a speech signal and generates a new frame every 20 msec. The speech coder includes a Voice Activity Detector (VAD) that evaluates whether the frame contains speech data or corresponds to a speech pause. If the frame does not contain speech, a SIlence Descriptor (SID) frame is generated and a flag, SP, is set indicating this to the channel coder. When using tandem operation this flag is not available to the channel coder. A GSM channel decoder will as mentioned in addition generate false frames meaning frames which are not SID frames or speech frames. These frames occur when a frame is lost or when no frame was transmitted during DTX and is indicated by setting the GSM flag BFI equal to 1. A speech frame received from a channel decoder can be recognised by the GSM flag SID being equal to 0 while a SID frame results in the SID flag being either equal to 1 or 2.

FIG. 3 illustrates a flowchart 300 of a method for providing discontinuous transmission according to the current invention, by way of example. The basic principle of the example is that the channel coding is performed based not only on speech frames and silence descriptor frames but also allows for false frames to be received. It furthermore does not require any additional information such as would be provided in the presence of a speech coder. This method allows the discontinuous transmission to be implemented in a communication system using tandem free operation such as the example GSM system illustrated in FIG. 2. The specific examples in the following description relates to a GSM system using discontinuous transmission together with tandem free operation.

At the beginning of the process illustrated in FIG. 3, the channel coder 113 is in non-discontinuous transmission mode. The first step 301 consists in receiving a frame. Step 303 evaluates if the frame received is a speech frame, and if so it will be processed in step 305 before returning to step 301. In GSM the processing of the speech frame will correspond to performing the necessary coding and arranging of the data and transmitting this over the air interface.

If the frame received was not a speech frame, step 307 evaluates if it is a false frame and if so processes this in step 309 before returning to step 301. In GSM this processing preferably consists in inserting a fill frame in the transmission which when received at the remote unit will result in the speech decoder of the mobile generating a replacement speech frame. Alternatively the channel coder may include means for generating a replacement speech frame and transmitting this to the remote unit. If the received frame was neither a false frame or a speech frame it must be a silence descriptor frame and this is processed by the channel coder in step 311. In GSM the processing preferably consists in transmitting a SID frame to the remote unit.

Following step 311 the channel coder receives the next frame in step 313. In step 315 it is evaluated if this is a speech frame and if so it is processed in step 317 before returning to step 301. Again, the preferred processing in GSM consists in transmitting the speech frame to the mobile according to the protocol set out in the GSM specification.

Step 319 evaluates if the received frame is a silence descriptor frame and if so it processes this in step 321 before returning to step 301. Alternatively step 321 may be followed by step 323 or step 311 depending on the specific embodiment. In GSM non-tandem operation using DTX two SID frames cannot be received consecutively and step 321 will thus never be reached.

In step 323, which is reached when the channel coder has received a silence descriptor frame followed by a false frame, the channel code enters a discontinuous transmission mode. In step 325 the current frame is processed according to the protocol for this discontinuous transmission mode

A flowchart 400 of the preferred method for processing the frame in discontinuous mode for a GSM system in tandem free operation using DTX is illustrated in FIG. 4. In step 401 it is evaluated if the received frame is a SID frame and if so this is stored in step 403 for later transmission. In step 405 it is evaluated if the GSM protocol requires a SID frame to be

transmitted over the air interface. If so the stored SID frame is transmitted in step 407. If not the channel coder proceeds at step 409 characterised in that no transmissions take place on the air interface.

In a GSM system using tandem free operation and DTX, the synchronisation between the first receiver 108 and the second transmitter 112 can be such that a SID frame is required to be transmitted on the air interface before it is received by the channel coder. For example, when the channel enters discontinuous transmission mode, it may be required to transmit a SID frame before the next SID frame is received from the channel decoder 107. However, a SID frame was in this case received shortly before entering discontinuous transmission mode and processed in step 311. The preferred process is therefore that the SID frame is stored in step 311. For the process illustrated in FIG. 4, a SID frame will in this case always be available for transmission when required, although when first entering discontinuous mode the same SID frame will be repeated. This will also be the case if a SID frame is lost during discontinuous transmission which occurs when the channel coder receives a frame with the GSM specified flags of SID and TAF both equal to 1.

After processing the current frame the channel coder receives a new frame in step 327. In step 329 it is evaluated if the received frame is a speech frame and if not the channel coder returns to step 325. If a speech frame has been received the channel coder exits the discontinuous transmission mode in step 331. It then processes the speech block in step 333 before returning to step 301. For GSM the processing of the speech block consists in transmitting it on the air interface as in step 305.

The preferred choice of implementing the described method in a channel coder is by running the above process as a software program in a suitable computational device as for example a microprocessor or a digital signal processor. The person skilled in the art may substitute any known method for this without detracting from the current invention.

Claims

1. A method for discontinuous transmission in a communication system comprising the steps of :

entering a discontinuous transmission mode when a first silence descriptor frame is followed by a first false frame; and

leaving the discontinuous transmission mode when a first speech frame is received.

2. A method as claimed in claim 1 further comprising the steps of :

transmitting said first silence descriptor frame when received.

3. A method as claimed in claim 1 further comprising the step of:

storing a second silence descriptor frame; and

when in discontinuous transmission mode, transmitting said second silence descriptor frame until a third silence descriptor frame is received, when a transmission of a silence descriptor frame is required by a protocol.

4. A method as claimed in claim 3 wherein transmission when in discontinuous transmission mode only occurs when the transmission of a silence descriptor frame is required.

5. A method for channel coding in a communication system comprising the steps of

transmitting a fill frame when not in a discontinuous transmission mode and a false frame is received.

6. A method as claimed in claim 5 further comprising the steps of:

entering the discontinuous transmission mode when a silence descriptor frame is followed by a false frame; and

leaving the discontinuous transmission mode when a speech frame is received.

7. A method as claimed in claim 6 further comprising the steps of :
storing a second silence descriptor frame; and
when in discontinuous transmission mode, transmitting said second silence descriptor frame when a transmission of a silence descriptor frame is required by a protocol until a third silence descriptor frame is received.

8. A method for discontinuous transmission in a GSM communication system using tandem free operation comprising the steps of :
entering a discontinuous transmission mode when a first silence descriptor frame is followed by a first false frame; and
leaving the discontinuous transmission mode when a first speech frame is received.

9. A method as claimed in claim 8 further comprising the steps of :
transmitting said first silence descriptor frame when received.

10. A method as claimed in claim 8 further comprising the step of:
storing a second silence descriptor frame; and
when in discontinuous transmission mode, transmitting said second silence descriptor frame until a third silence descriptor frame is received, when a transmission of a silence descriptor frame is required by a protocol.

11. A method as claimed in claim 10 wherein transmission when in discontinuous transmission mode only occurs when the transmission of a silence descriptor frame is required.

12. A method for channel in a GSM communication system using tandem free operation comprising the steps of:
transmitting a fill frame when not in a discontinuous transmission mode and a false frame is received;
entering the discontinuous transmission mode when a silence descriptor frame is followed by a false frame; and

leaving the discontinuous transmission mode when a speech frame is received.

13. A transmitter in a communication system providing discontinuous transmission comprising:

means for entering a discontinuous transmission mode when a first silence descriptor frame is followed by a first false frame; and

means for leaving the discontinuous transmission mode when a first speech frame is received.

14. A transmitter as claimed in claim 13 wherein said first silence descriptor frame is transmitted when received.

15. A transmitter as claimed in claim 13 further comprising:

means for storing a second silence descriptor frame; and

means for when in discontinuous transmission mode, transmitting said second silence descriptor frame until a third silence descriptor frame is received, when a transmission of a silence descriptor frame is required by a protocol.

16. A transmitter as claimed in claim 15 wherein transmission, when in discontinuous transmission mode, only occurs when the transmission of a silence descriptor frame is required.

The Patent Office

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Application No: GB 9726879.1 **Examiner:** Anita Keogh
Claims searched: 1-4, 8-11, 13-16 **Date of search:** 17 June 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4L (LDLX, LDSY)

Int Cl (Ed.6): H04B (7/005, 7/26), H04Q (7/30, 7/38)

Other: ONLINE WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2313259 A	(MOTOROLA)	
A	WO 96/28809 A1	(ERICSSON)	
A	WO 96/24200 A1	(NOKIA)	
A	US 5537509	(SWAMINATHAN et al.) See particularly column 5, lines 34-45	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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